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# MINERAL COMMODITY REPORT
# —— MAGNESIUM COMPOUNDS ——

## 1985

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

**SPECIAL PUBLICATION 77**

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SPECIAL PUBLICATION 77

# MINERAL COMMODITY REPORT

# —— MAGNESIUM COMPOUNDS ——

1985

By

HASMUKHRAI H. MAJMUNDAR

Part I from

U .S. Bureau of Mines Publication

Mineral Commodity Summaries, 1984

CALIFORNIA DEPARTMENT OF CONSERVATION

DIVISION OF MINES AND GEOLOGY

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# INTRODUCTION

This report on the availability and demand for magnesium compounds in the United States, the world, and California, is one of a series of Mineral Commodity Reports prepared by the Department of Conservation's Division of Mines and Geology (DMG) to describe the mineral commodities of significant importance to California and the nation.

This mineral commodity report was compiled by Hasmukhrai H. Majmundar of the DMG geologic staff. Part I consists of United States and world-wide mineral-statistic information and analysis adopted directly from the U.S. Bureau of Mines "Mineral Commodity Summaries, 1984." Part II discusses production of the commodity in California. The U.S. Bureau of Mines presents the earliest Government estimates of non-fuel mineral-industry data, including world resources data provided by the U.S. Geological Survey.

For further information, please call (916) 445-5716, the DMG centralized information number.

In 1983 the United States produced 550,000 short tons of magnesium compounds, imported 37,000 short tons for consumption, exported 24,000 short tons, and had an apparent consumption of 563,000 short tons of magnesium compounds. The imports were from Ireland (49 percent), Greece (18 percent), Japan (16 percent), India (7 percent), and other countries (10 percent) It was suggested that the magnesium compounds industries operated at about three-fifths of their capacity. The apparent production and domestic consumption of magnesium compounds are expected to surpass the levels of 1983 in coming years. The demand for magnesium compounds is estimated to increase at an annual rate of about 1.8 percent through 1990.

Magnesium compounds are used to prepare refractories and industrial and pharmaceutical chemicals. Roughly 75 percent of all magnesium compounds produced in the United States is used for the basic refractories in high temperature metallurgical furnaces in iron and steel industries and certain parts of base-metal smelters. The remaining 25 percent is used in the preparations of caustic-calcined and specified magnesias and other magnesium compounds. Markets served by the industries manufacturing magnesium compounds are steel, glass, portland cement, copper and lead industries, and the magnesia calcining plants (refractories) themselves. The magnesium compounds are also marketed among the paper-mills and sugar industries, in landscaping, highway construction, and soil neutralization. In 1983, nationwide, about 900 workers were employed in plants producing refractory and other magnesium compounds.

The important source rocks for magnesium compounds are massive sedimentary or metamorphic deposits and veins of dolomite, magnesite, brucite, hydromagnesite, and the silicate minerals olivine, forsterite, and serpentine. The other sources of magnesium compounds are the marine and terrestrial brines, salt work bitterns, and the sea water. Seven companies produced magnesia and other magnesium compounds from sea water in California, Delaware, Florida, New Jersey, and Texas. For producing magnesium compounds, three companies utilized the well brines in Michigan, three companies utilized lake brines in Utah, one company mined magnesite in Nevada, and two companies

mined olivine in North Carolina and Washington. Out of these magnesia and magnesium compounds manufacturing, three companies produced 80 percent of the domestic magnesia. Magnesium hydroxide can easily be recovered from sea water at locations on the coast where salinity is highest.

Recoverable magnesium-compounds resources are unlimited and widespread in the world. Identified world resources for magnesite are of the magnitude of 12 billion tons. Resources of brucite are several million tons and for dolomite, forsterite, and magnesium-bearing evaporite minerals are enormous. Magnesium-bearing brines resources are in billions of tons.

The potential alternates for silica foundry sand and sand-blasting sand are the naturally occurring magnesium compounds olivine and dunite. Over and above this, olivine also has limited use for slag and alkali control in steel-making industries. Alumina and zinc can be substituted for magnesium castings, and wrought products and alumina and silica can be substituted for magnesia in some refractories.

## PART I: UNITED STATES AND WORLDWIDE

### 1. UNITED STATES PRODUCTION AND USE

Magnesium Compounds: Magnesium oxide and other compounds were produced from sea water by seven companies in California, Delaware, Florida, New Jersey, and Texas; by three companies from well brines in Michigan, and by two companines from lake brines in Utah. Magnesite was mined by one company in Nevada; and olivine by two companies in North Carolina and Washington. Three companies accounted for almost 80 percent of the magnesia production. Three-fourths of the consumption of magnesium compounds was for the production of basic refractories used in high temperature metallurgical furnaces for making products such as iron and steel. The remainder was used to prepare caustic-calcined and specified magnesias and other magnesium compounds.

### 2. SALIENT STATISTICS - UNITED STATES

Magnesium Compounds (Data in thousand short tons of magnesium content, unless noted)

| | 1979 | 1980 | 1981 | 1982 | 1983[e] |
|---|---|---|---|---|---|
| Production: | 1,002 | 800 | 761 | 564 | 550 |
| Imports for consumption | 60 | 52 | 51 | 44 | 37 |
| Exports | 61 | 65 | 35 | 22 | 24 |
| Apparent consumption | 1,001 | 787 | 777 | 586 | 563 |
| Stocks: producers, yearend | | Not available | | | |
| Employment: Plant | 1,000 | 1,000 | 1,000 | 900 | 900 |
| Net import reliance[1] as a percent of apparent consumption | E | E | 2 | 4 | 2 |

### 3. RECYCLING

None

### 4. IMPORT SOURCES (1979-82)

Ireland 49%, Greece 18%, Japan 16%, India 7%, Other 10%.

---

e Estimated. E Net Exporter.
1 Defined as imports - exports + adjustments for Government and industry stock changes.

Prepared by B. Petkof, telephone number (202) 634-1073.

5. TARIFF[2]

| | Number | Most Favored Nation (MFN) 1/1/84 | Most Favored Nation (MFN) 1/1/87 | Non-MFN 1/1/84 |
|---|---|---|---|---|
| Crude magnesite | 522.61 | $0.98/ton | Free | $10.50/ton |
| Caustic-Calcined magnesite | 522.64 | $2.10/ton | $2.10/ton | $21.00/ton |
| Refractory magnesia (containing under 4% lime) | 531.01 | 0.17¢/lb. | 0.16¢/lb | 0.75¢/lb |
| Refractory magnesia (containing over 4% lime) | 531.04 | 6.0% ad val. | 6.0% ad val. | 30.0% ad val. |

6. DEPLETION ALLOWANCES

Brucite 10% (Domestic and Foreign); dolomite and magnesium carbonate 14% (Domestic and Foreign); magnesium chloride 5% (Domestic and Foreign); and olivine 22% (Domestic) and 14% (Foreign).

7. GOVERNMENT STOCKPILE

None.

8. EVENTS, TRENDS, AND ISSUES

It is estimated that in 1984 domestic magnesium compound production from all sources will be 560,000 tons and U.S. apparent consumption will be 575,000 tons. From a 1978 base, demand for nonmetallic-magnesium is expected to increase at an annual rate of about 1.8% through 1990. It was estimated that in 1983 the magnesium compounds industry operated at almost three-fifths of capacity.

Olivine and dunite, natural occurring magnesium compounds, are potential alternates for silica foundry sand and sand-blasting sand. In addition, olivine had limited use for slag and alkali control in steelmaking.

[2] Tariffs are based on gross weight.

9. WORLD PRODUCTION AND RESERVE BASE

| Country | Magnesite Production 1982 | Magnesite Production 1983e | Magnesite | Reserve Base* Well and lake brines and seawater |
|---|---|---|---|---|
| United States | W | W | 10,000 | |
| Australia | 8 | 5 | 95,000 | |
| Austria | 365 | 350 | 15,000 | |
| Brazil | 95 | 100 | 150,000 | |
| Canada | 22 | 25 | 30,000 | |
| Greece | 254 | 250 | 30,000 | |
| India | 118 | 120 | 30,000 | |
| Turkey | 248 | 250 | 10,000 | |
| Yugoslavia | 104 | 110 | 5,000 | |
| Other Market Economy Countries | 203 | 200 | 350,000 | |
| China | 634 | 635 | 820,000 | |
| Czechoslovakia | 210 | 210 | 20,000 | |
| Korea, North | 588 | 590 | 490,000 | |
| U.S.S.R. | 683 | 680 | 720,000 | |
| Other Centrally Planned Economies | 4 | 5 | 10,000 | |
| World Total (rounded)[3] | 3,540 | 3,530 | 2,800,000 | vast |

10. WORLD RESOURCES

Resources from which magnesium compounds may be recovered range from large to virtually unlimited and are globally widespread. Identified world resources of magnesite total 12 billion tons, and of brucite, several million tons. Resources of dolomite, forsterite, and magnesium-bearing evaporite minerals are enormous; magnesia-bearing brines are estimated to constitute a resource in billions of tons; and magnesium hydroxide can be recovered from seawater at places along world coast lines where salinity is highest.

11. SUBSTITUTES

Alumina and silica can be substituted for magnesia in some refractories.

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* Pending establishment of criteria for the reserve base, classification of data is based on a judgmental appraisal of current knowledge and assumptions.

[3] Excludes U.S. production.

## PART II: CALIFORNIA

### 12. CALIFORNIA GEOLOGICAL AND MINERAL OCCURRENCES

Magnesium compounds are produced from sea water, natural and synthetic brines, and massive bedrock and vein deposits. In California, they occur in the following natural environments:

(1) in sea water, in marine and terrestrial brines, and in salt work bitterns;

(2) massive sedimentary or metamorphic deposits and veins of dolomite, magnesite, brucite, hydromagnesite; and

(3) as silicate minerals -- olivine, forsterite, and serpentine.

Magnesium compounds are present in solution, in soluble salts derived from the evaporation of brines, in massive rocks and in veins. After sodium, magnesium is the next most abundant metal in sea water. In sea water, magnesium occurs in combination with chloride and sulfate; but calculated in terms of magnesia, sea water of an average composition has an equivalent of 0.21 percent MgO. Magnesium in higher amounts occurs in the bittern, which is the end mother liquor left over from the solar evaporation of sea water, from which most of the salt (NaCl), carbonates, and gypsum were precipitated. Certain terrestrial brines are also good sources of magnesium compounds. An example of such terrestrial brines is from Bristol Lake in San Bernardino County. As yet, magnesium compounds have not been recovered from this lake. Magnesium salts are very soluble. The most common ones are complex chlorides and sulfates of magnesium with additional metal of potassium or sodium. California does not have deposits of the potassium-bearing magnesium salts. The most important insoluble magnesium ore minerals are magnesite and dolomite. Dolomite most commonly occurs as a sedimentary or metamorphic rock. Two other minerals, brucite and hydromagnesite, are also ore minerals, but they do not occur in commercial quantities in California. The magnesium silicate minerals, like olivine, forsterite, and serpentine, have some minor uses as refractories and sources of magnesium compounds, and they may be future sources for consideration.

The mineral magnesite occurs as: (a) replacement bodies in dolomite; (b) fracture fillings and replacement bodies in serpentine; and (c) sedimentary deposits associated with playa lake beds. But the larger magnesite deposits of the world are of the dolomite replacement type. This type of magnesite is crystalline as compared to the cryptocrystalline or amorphous magnesite deposits associated with serpentine and lake beds. As a rule, the magnesite ore bodies in dolomite are very large but impure, and the ones associated with serpentine are small but pure. In general, the sedimentary deposits are small and impure.

## 13. CALIFORNIA LOCALITIES

Magnesium compounds are being produced from sea water at Moss Landing in Monterey County and at South San Francisco in San Mateo County. In the past, they were also produced from the salt work bitterns at Chula Vista in San Diego County and at Newark in Alameda County. Dolomite used for these plants came from the dolomite quarries near Natividad in Monterey County, Columbia in Tuolumne County, and Hollister in San Benito County.

Most of the magnesite deposits are associated with serpentine and occur in the Coast Ranges and the western foothills of the Sierra Nevada. The Red Mountain district magnesite deposits are the largest, located on the border of Santa Clara and Stanislaus counties. The Western mine is in this district, where magnesite is formed in a large sheeted ultrabasic body and occurs as replacement of serpentine in shear zones and tension fractures and fissure fillings. This type of association of magnesite and serpentine is considered to be an alteration product resulting from the action of aqueous solutions rich in carbon dioxide on magnesium silicates.

The magnesite deposits at the Bald Eagle mine in the Stanislaus County are probably the second largest in the state. These deposits are also replacement deposits and occur near the base of a brecciated serpentine body, which is underlain by Franciscan melange. Magnesite deposits occur as moderately-dipping tabular bodies.

Small replacement deposits associated with dolomite occur near Barstow and Mountain Pass in San Bernardino County.

Small sedimentary deposits of impure magnesite occur near Afton and Needles, and in Kramer Hills in San Bernardino County, and near Bissell in Kern County. This crypotcrystalline magnesite is interbedded with folded Tertiary playa lake sediments. The magnesite is believed to have been precipitated from the saline lake waters.

Magnesite was mined in the past at the Porterville district, east of Porterville, Lindsay, and Exeter in Tulare County; it was also mined from the Sampson mine in San Benito County, the Snowflake and Blanco mines in Chiles Valley and the White Rock mine in Pope Valley in Napa County, a mine on Austin Creek north of Cazadero in Sonoma County, and a mine on Cedar Mountain in Alameda County. Magnesite was also mined from Fresno, Kings, Mendocino, Placer, Riverside, and Tuolomne counties. At all of these locations, the deposits of magnesite are associated with serpentine.

There had been attempts to mine the deposits of soluble magnesium minerals (epsomite) from San Bernardino County, where efflorescent salts occur on the Tertiary clay beds.

## 14. CALIFORNIA PRODUCTION

Only two plants in California produce magnesium oxide and magnesium hydroxide from sea water. One of them is the Kaiser Refractories Division plant of Kaiser Aluminum and Chemical Corporation at Moss Landing in Monterey County; the second one is the Merck Chemical Division plant of Merck and Company Incorporated at South San Francisco in San Mateo County. This plant, originally known as the Marine Chemical Company plant, was sold to the Merck and Company Incorporated around 1954.

Kaiser's Moss Landing plant includes three separate plants: the Natividad dolomite quarry with the calcining plant, the sea water magnesia plant, and the basic refractory brick and specialty plant. These three plants cover an area of about 1,335 acres and are three of the eight manufacturing facilities in the United States operated by Kaiser Refractories. The company also owns, either in whole or in part, four additional plants outside the United States. Kaiser has subsidiaries in Australia and Canada and has licenses in Argentina, France, Japan, New Zealand, Sweden, and United Kingdom. The yearly production of the Moss Landing plants averages 175,000 tons of magnesia; 165,000 tons of magnesium hydroxide; 44,000 tons of basic refractory brick; 47,000 tons of basic refractory specialties; 230,000 tons of calcined dolomite; 150,000 tons of sized rock products; and 50,000 tons of dead-burned dolomite.

Merck's South San Francisco plant is producing industrial grade and high purity pharmaceutical-grade magnesium oxide and magnesium hydroxide. The production figures for this plant are proprietary data.

Kaiser Refractories ship refractory material from Moss Landing to all their plants in the U.S. as well as abroad. They also supply magnesia to other plants in the U.S. Merck Company supplies oxides and hydroxides of magnesium throughout the U.S.

## 15. UTILIZATION AND MARKETS

Magnesium compounds are used to prepare refractories and chemicals. About 75 percent of the magnesium compounds produced in the U.S. are marketed for refractory purposes. High-temperature refractories are indispensable as linings in modern steel furnaces and in certain parts of base-metal smelters. Reactive magnesium chemicals have well-established industrial and pharmaceutical uses.

Basic refractory bricks for the furnace walls are made from dead-burned magnesite with periclase and chromite. The steel industry uses about 5 pounds of refractory magnesia for each ton of steel produced.

Caustic calcined magnesite has many uses. Depending on the specific need of the customers, different products of specific compositions are made. One of the oldest uses is in the manufacure of magnesium oxychloride cement, which after setting, becomes hard and strong, and can be cut and polished, nailed, and fastened with screws. But its main use is for ship decks and floors of railroad cars. Caustic calcined magnesite is also used in the manufacture of rayon, as an active ingredient in rubber, and as an absorbent.

## LIST OF PLANTS
(Present day)

1. Kaiser Refractories Division, Kaiser Aluminum and Chemical Corporation, Moss Landing, Monterey County.
2. Merck Chemical Division, Merck and Company Incorporated, South San Francisco, San Mateo County.

(Past)

3. Westvaco Chemical Division, Food Machinery and Chemical Corporation (FMC), Chula Vista, San Diego County.
4. Westvaco Chemical Division, Food Machinery and Chemical Corporation (FMC), Newark, Alameda County.

## LIST OF DEPOSITS

5. Red Mountain District, Border of Santa Clara and Stanislaus Counties.
6. Western mine, Santa Clara County.
7. Bald Eagle mine, Stanislaus County.
8. Harker mine, Tulare County.
9. Success area, Tulare County.
10. Sampson mine, San Benito County.
11. Snowflake and Blanco mines, Chiles Valley, Napa County.
12. White Rock mine, Pope Valley, Napa County.
13. Red Slide deposit, Sonoma County.
14. Cedar Mountain, Alameda County:
15. Fresno County.
16. Kings County.
17. Hixon Ranch, Mendocino County.
18. Sullivan, Placer County.
19. Hemet, Riverside County.
20. Gray Eagle mine, Tuolumne County.
21. Bastro deposits, San Bernardino County.
22. Mountain Pass deposits, San Bernardino County.
23. Afton deposits, San Bernardino County.
24. Needles deposits, San Bernardino County.
25. Kramer deposits, San Bernardino County.
26. Bissell deposits, Kern County.
27. Searles Lake (20 miles east of Searles Lake and west of Owlshead Mountains), San Bernardino County.

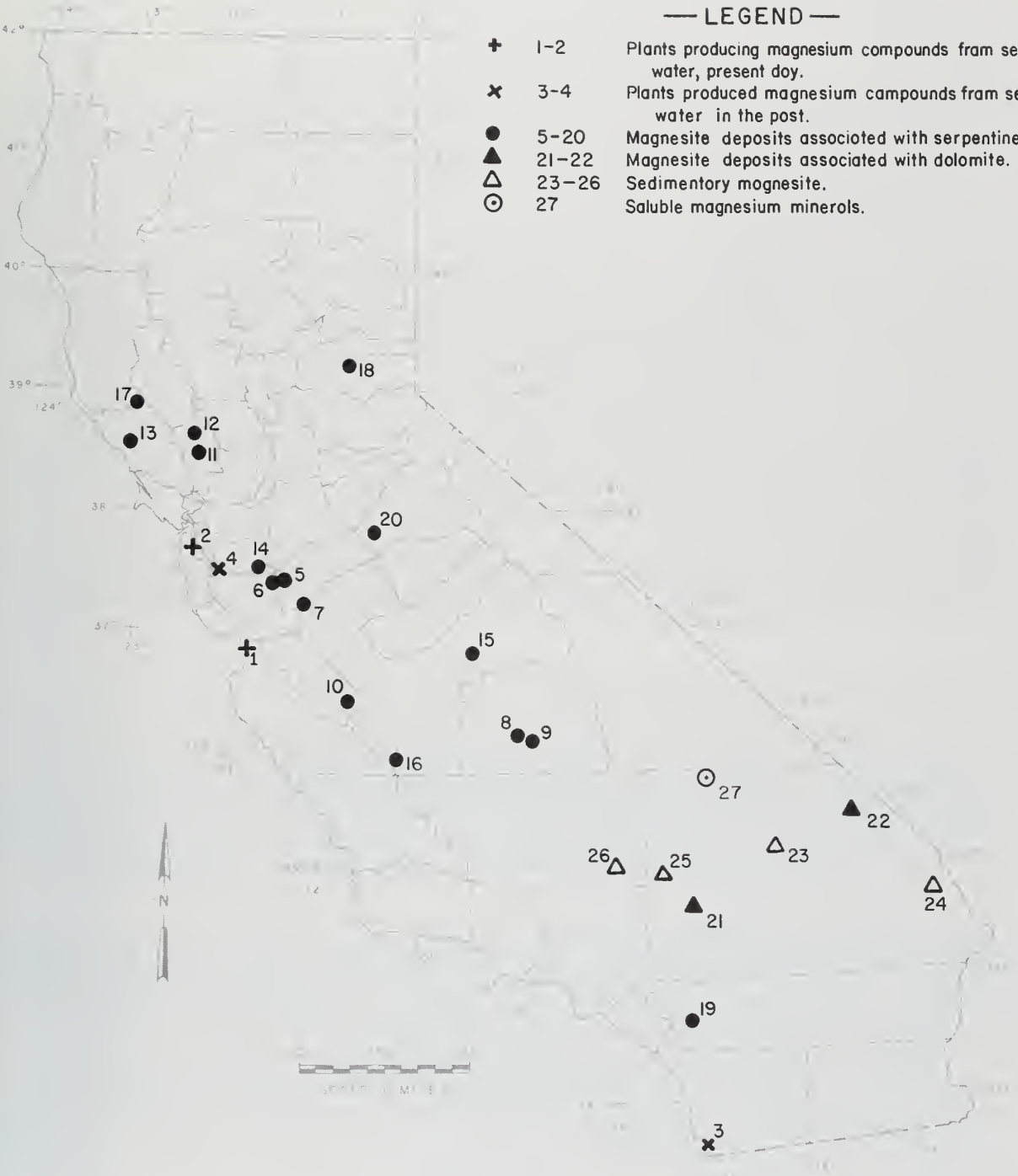
— LEGEND —
+ 1-2 Plants producing magnesium compounds fram sea water, present doy.
× 3-4 Plants produced magnesium campounds fram sea water in the post.
● 5-20 Magnesite deposits associoted with serpentine.
▲ 21-22 Magnesite deposits associated with dolomite.
△ 23-26 Sedimentory mognesite.
⊙ 27 Saluble magnesium minerols.
N

FIGURE 1. Magnesium Compounds deposits in California

Magnesite is the world's main source of magnesia. (In California, synthetic magnesite, prepared from sea water, is used instead.) Uncalcined magnesite is used for producing magnesium sulfate and magnesium chloride. The magnesium oxide and other magnesium compounds have also other numerous industrial uses--for example, thermal insulation.

Other magnesium compounds like magnesium hydroxide, magnesium chloride, magnesium sulfate, and magnesium carbonate also have commercial uses. In California, magnesium hydroxide is used for the manufacture of basic magnesium carbonate (elsewhere in the U.S., it is made from dolomite), which, in turn, is used for thermal insulation. Small quantities of high-purity magnesium hydroxide are also used in pharmaceuticals. Magnesium chloride is used in the manufacture of magnesium oxychloride cement, as a ceramic raw material, for sizing of paper, and for producing magnesium metal by electrolysis. Magnesium sulfate is used as a fireproofing and sizing agent. Epsom salt is also prepared by hydration of magnesium sulfate.

Markets served by the magnesium compounds manufacturing industries are the steel, glass, portland cement, copper and lead industries; the magnesia calcining plants themselves (refractories); and the sugar and paper industries--as well as landscaping, highway construction, and soil neutralization (dolomite and magnesia).

The three Kaiser Refractories operations in Moss Landing employ 425 employees with an annual payroll of $13.5 million (1982 figures) and pay $650,000 in County taxes. At present, a total of 395 employees are on payroll of this company at Moss Landing plants.

Merck Chemical Division's plant in South San Francisco employs a total of 120 persons in the chemical plant and 15 in the quarry operations at Columbia, Tuolumne County.

## 16. MINING METHODS AND BENEFICIATION

The essential raw material used in the two productive plants of California is sea water. Normally, the Bay water contains the equivalent of approximately 2 grams of magnesium oxide per liter of sea water. The two other plants (Westvaco's Chula Vista and Newark plants), which were closed down in the past, used the bitterns left over after the salt (NaCl) production.

In the magnesia plant at Moss Landing, the calcined dolomite from Kaiser's Natividad quarry is used along with the pumped sea water from the Elkhorn slough. Sea water is treated with a portion of the calcined dolomite slurry to precipitate carbon dioxide from the sea water as calcium carbonate. The rest of the calcined dolomite is added to the carbon dioxide-free sea water to make magnesium hydroxide. The calcium of the dolomite is replaced here by magnesium from the sea water. Magnesium, in fact, originates in approximately equal proportions from both the dolomite and the sea water, precipitating as magnesium hydroxide. It is thickened, washed free of chlorides with fresh water, and then dewatered with

filters. Most of the filtered cake is calcined, but some is marketed without further treatment. Magnesias of different compositions are manufactured by the addition and/or blending of small quantities of iron, silica, chromite, and other material, and by varying the temperature during the manufacturing process.

The South San Francisco plant of Merck Chemical Division also uses sea water and calcined dolomite to produce oxides and hydroxides of magnesium. The dolomite is mined at a quarry near Columbia, Tuolumne County. The procedure and treatment in this chemical plant are almost the same as those used by Kaiser. The only difference is that here the sea water is treated first with chlorine gas to kill organic matter and then calcined dolomite slurry is added. Depending on the product desired, the magnesium hydroxide is dried, carbonated, or calcined. When the Sacramento River is in flood, the Bay water is diluted and the plant has to use additional salt-work bittern along with this diluted sea water.

The Westvaco Chemical plants of Food Machinery and Chemical Corporation (FMC) used bittern to produce magnesia, bromine, and gypsum at the Newark plant; and magnesium chloride at the Chula Vista plant. For the last 20 years or so, both of these plants have stopped producing magnesium compounds. At the Chula Vista plant, the bittern was heated to obtain the concentrate of magnesium chloride. At the Newark plant, sulfate was removed by addition of calcium chloride-rich end liquor. The gypsum was precipitated, removed, and dried. Then the sulfate-free bittern, consisting only of chlorides of magnesium and sodium, was reacted with calcined dolomite. Magnesium hydroxide thus obtained was then treated with silica, alumina, iron oxide, or lime, to produce the desired quality of magnesia. Bromine was recovered from the bittern in the beginning. For this operation, dolomite was mined from the company's quarry in San Benito County near Hollister and calcined at Newark.

## 17. CALIFORNIA EVENTS, TRENDS, AND ISSUES

Due to the decrease in the demand of refractory material, Kaiser Refractories Division's Moss Landing plant had to cutback the manufacture of refractory bricks and announced the temporary closing of the plant and the quarry in 1981 to reduce the inventories. There is a possibility of similar cutbacks in the future. For example, at present, Kaiser has reduced about 30 persons from the 1982 figure of employees.

Present conditions do not favor the mining of magnesite in California because of the differing composition of the magnesite deposits as compared to sea-water magnesia. Manufacturers of magnesia in this state no longer use natural magnesite these days to make magnesia. The other factors not in favor of using natural magnesite are the distance of the deposits from the market, increased costs of mining and steeply-dipping, narrow, discontinuous deposits of California magnesite. Maybe with improved technology and increased demands, these deposits can be utilized in the future.

Olivine, forsterite, serpentine, brucite, and hydromagnesite are the other possible resources for future consideration in California.

## 18. GLOSSARY OF MAGNESIUM OXIDE COMPOUNDS

To avoid confusion with the terminology of the magnesium oxide compounds, the following definitions and explanations should be helpful:

| | |
|---|---|
| MAGNESITE: | In a strict sense, natural magnesium carbonate ($MgCO_3$). |
| MAGNESIA: | In a strict sense, magnesium oxide (MgO). |
| NATURAL MAGNESIA: | Mineral periclase. |
| CALCINED MAGNESITE: | Roughly synonymous with magnesia because, by heating, magnesite is changed to magnesia (mgO) and carbon dioxide ($CO_2$). But in practice, the term calcined is often dropped. The term magnesite commonly means magnesia obtained by the calcination of the mineral magnesite or of some other magnesium compound such as natural or synthetic hydroxide [$Mg(OH)_2$)]. The chemical and physical properties of the commercial magnesias are much influenced by the temperature of calcination. These magnesias are grouped into two classes: dead-burned magnesite and caustic calcined magnesite. |
| DEAD-BURNED MAGNESITE: | Produced by calcining magnesium carbonate or magnesium hydroxide at 1560°C or higher temperatures. They are chemically inert and contain between 2 percent to less than 0.5 percent carbon dioxide and various proportions up to 15 percent of iron oxide, silica, alumina, and lime as impurities in the raw material or added to it. These materials act as fluxes. |
| CAUSTIC CALCINED MAGNESITE: | Produced by calcining magnesium carbonate or magnesium hydroxide at temperatures of 1200°C or less. It has up to 97 percent MgO and between 1 and 5 percent $CO_2$ or combined water. Iron oxide, silica, alumina, and lime are some of the nondesirable diluents. |
| PERICLASE: | The name given to a dense crystalline magnesia containing over 90 percent MgO with silica as the major additive; it is produced by calcination at about 1760°C. Nowadays, it is made from synthetic magnesium hydroxide. |
| SYNTHETIC MAGNESIA: | Magnesium oxide produced from sea water, brines, or bitterns and not from the naturally-occurring mineral magnesite. |

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